CLAIMS

1. A lithographic projection apparatus, comprising:

a support structure configured to hold a patterning device, the patterning device configured to pattern a beam of radiation;

a substrate table configured to hold a substrate;

an actuator configured to move at least one of the support structure and the substrate table;

a controller configured to provide a motion signal to the actuator, the motion signal controlling the actuator to produce a motion of the at least one of the support structure and the substrate table, an absolute value of at least one of a fourth and a higher derivative to time of the position of the motion being limited to less than a maximal value; and

a projection system configured to project the patterned beam onto a target portion of the substrate.

2. The apparatus of claim 1, wherein the motion signal comprises a motion signal for a desired position of the at least one of the support structure and the substrate table.

3. The apparatus of claim 2, comprising a trajectory planner configured to generate the motion signal by constructing a function of time that is to serve as the n^{th} derivative to time of the motion signal and integrating the constructed function n times, where $n \geq 4$.

4. The apparatus of claim 3, wherein constructing the function of time comprises defining consecutive time intervals with a substantially constant function value.

5. The apparatus of claim 4, wherein the substantially constant function value in each consecutive time interval is either a maximal positive value, a maximal negative value of the substantially same absolute value as the maximal positive value, or zero.

6. The apparatus of claim 3, wherein intermediate results of integrating the constructed

function of time are determined, including a jerk profile, an acceleration profile, a velocity profile, and a position profile, the position profile corresponding to the motion signal, as respective integrals of the constructed function of time.

7. The apparatus of claim 6, wherein an absolute value of at least one of the jerk profile, the acceleration profile, the velocity profile and the position profile is limited to less than a maximal value.

8. The apparatus of claim 1, wherein the maximal value in advance of at least one of a substantially constant velocity phase and a stopping point of the motion is less than the maximal value of another part of the motion.

9. The apparatus of claim 8, wherein the maximal value in advance of the at least one of the substantially constant velocity phase and the stopping point is less than or equal to 25% of the maximum value of another part of the motion.

10. The apparatus of claim 8, wherein the maximal value in advance of the stopping point is less than or equal to 50% of the maximal value of another part of the motion and a maximal value of the jerk of the motion in advance of the stopping point is less than or equal to 50% of the maximal value of the jerk of another part of the motion.

11. The apparatus of claim 1, wherein the motion of the at least one of the support structure and the substrate table is in a scanning direction.

12. The apparatus of claim 1, wherein the motion of the substrate table is in a stepping direction.

13. The apparatus of claim 1, wherein the motion of the substrate table is in a stepping direction and in a scanning direction.

14. The apparatus of claim 1, wherein the maximal value for a negative acceleration phase in the motion equals the maximal value of a positive acceleration phase in the motion.

15. The apparatus of claim 1, wherein the maximal value for a negative acceleration in the motion is greater than or equal to 10 and less than or equal to 20 times the maximal value of a positive acceleration for starting the motion.

16. The apparatus of claim 1, wherein the motion signal is determined using a feed-forward comprising at least one of a fourth and a higher derivative to time of the position of the motion limited to less than a maximal value.

17. A lithographic apparatus, comprising:

a support structure configured to hold a patterning device, the patterning device configured to pattern a beam of radiation;

a substrate table configured to hold a substrate;

an actuator configured to move a part of the lithographic apparatus in at least one degree of freedom in accordance with a set-point signal for a desired position of the part, at least one of a fourth and a higher derivative to time of the set-point signal being limited to a boundary; and

a projection system configured to project the patterned beam onto a target portion of the substrate.

18. A computer program product to control motion of at least one of a substrate table and a patterning device support structure in a lithographic apparatus, comprising software code configured to generate motion data used to control an actuator to produce a motion of the at least one of the support structure and the substrate table, an absolute value of at least one of a fourth and a higher derivative to time of the position of the motion being limited to less than a maximal value.

19. The computer program product of claim 18, comprising software code configured to

provide a motion signal for an actuator, said motion signal corresponding to a desired position of the at least one of the support structure and the substrate table

20. The computer program product of claim 18, wherein the maximal value in advance of at least one of a substantially constant velocity phase and a stopping point of the motion is less than the maximal value of another part of the motion.

21. The computer program product of claim 18, wherein the motion of the at least one of the support structure and the substrate table is in a scanning direction of the lithographic apparatus.

22. The computer program product of claim 18, wherein the motion of the substrate table is in a stepping direction of the lithographic apparatus.

23. The computer program product of claim 18, wherein the motion of the substrate table is in a stepping direction and in a scanning direction of the lithographic apparatus.

24. The computer program product of claim 18, wherein the motion signal is determined using a feed-forward comprising at least one of a fourth and a higher derivative to time of the position of the motion limited to less than a maximal value.

25. A device manufacturing method comprising:

actuating at least one of a mask table and a substrate table of a lithographic apparatus in at least one degree of freedom using a set-point signal for the desired position of the at least one of the mask table and the substrate table, at least one of a fourth and a higher derivative to time of the set-point signal being limited to a maximum; and

projecting a patterned beam of radiation onto a target portion of a substrate held by the substrate table.

26. The method of claim 25, wherein the degree of freedom includes a scanning direction of the lithographic apparatus.

27. The method of claim 25, wherein the degree of freedom includes a stepping direction of the lithographic apparatus.

28. The method of claim 25, comprising reducing the maximal value in advance of at least one of a substantially constant velocity phase and a stopping point of the motion to less than the maximal value of another part of the motion.

29. The method of claim 25, wherein the set-point signal is determined using a feed-forward comprising at least one of a fourth and a higher derivative to time of the set-point signal limited to a maximum.

30. A lithographic projection apparatus, comprising:

a support structure configured to hold a patterning device, the patterning device configured to pattern a beam of radiation;

a substrate table configured to hold a substrate;

an actuator connected to at least one of the support structure and the substrate table;

a controller configured to provide a motion signal to the actuator, the motion signal controlling the actuator to produce an acceleration of at least one of the support structure and the substrate table having a high at least one of a third and a higher derivative to time of the position of the motion at a start portion of the acceleration and a corresponding low at least one of a third and a higher derivative to time of the position of the motion at an end portion of the acceleration, the absolute value of the high at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the corresponding low at least one of the third and the higher derivative to time of the position of the motion; and

a projection system configured to project the patterned beam onto a target portion of the substrate.

31. The apparatus of claim 30, wherein the absolute value of the third derivative to time of the position of the motion is less than a maximal value.

32. The apparatus of claim 30, wherein the absolute value of at least one of a fourth and a higher derivative to time of the position of the motion is less than a maximal value.

33. The apparatus of claim 30, wherein the motion signal controls the actuator to produce acceleration having a corresponding substantially zero at least one of a third and a higher derivative to time of the position of the motion for an intermediate period between the start portion and the end portion.

34. The apparatus of claim 30, wherein the acceleration is a positive acceleration and the controller is further configured to provide a motion signal to the actuator, the motion signal controlling the actuator to produce a negative acceleration of the at least one of the support structure and the substrate table having a high negative acceleration at least one of a third and a higher derivative to time of the position of the motion, the absolute value of the high negative acceleration at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the corresponding low at least one of the third and the higher derivative to time of the position of the motion.

35. The apparatus of claim 34, wherein the negative acceleration comprises the high negative acceleration at least one of the third and the higher derivative to time of the position of the motion for a start period and the high negative acceleration at least one of the third and the higher derivative to time of the position of the motion for an end period.

36. The apparatus of claim 35, wherein the negative acceleration comprises a corresponding substantially zero at least one of a third and a higher derivative to time of the position of the motion for an intermediate period between the start period and the end period.

37. The apparatus of claim 30, wherein the acceleration is a positive acceleration and the controller is further configured to provide a motion signal to the actuator, the motion signal controlling the actuator to produce a negative acceleration of the at least one of the support

structure and the substrate table having a low negative acceleration at least one of a third and a higher derivative to time of the position of the motion at a start period of the negative acceleration and a corresponding high negative acceleration at least one of a third and a higher derivative to time of the position of the motion, the absolute value of the corresponding high negative acceleration at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the low negative acceleration at least one of the third and the higher derivative to time of the position of the motion.

38. The apparatus of claim 30, wherein the acceleration comprises a positive acceleration phase and negative acceleration phase.

39. The apparatus of claim 30, wherein the acceleration comprises a scanning direction.

40. The apparatus of claim 30, wherein the acceleration comprises a stepping direction.

41. The apparatus of claim 40, wherein the acceleration further comprises a scanning direction.

42. The apparatus of claim 30, wherein the motion signal comprises a position signal.

43. A computer program product to control motion of at least one of a patterning device support structure and a substrate table in a lithographic apparatus, comprising software code configured to generate motion data used to control an actuator to produce an acceleration of the at least one of the patterning device support structure and the substrate table having a high at least one of a third and a higher derivative to time of the position of the motion at a start portion of the acceleration and a corresponding low at least one of a third and a higher derivative to time of the position of the motion at an end portion of the acceleration, the absolute value of the high at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the corresponding low at least one of the third and the higher derivative to time of the position of the motion.

44. The computer program product of claim 43, wherein the absolute value of the third derivative to time of the position of the motion is less than a maximal value.

45. The computer program product of claim 43, wherein the absolute value of at least one of a fourth and a higher derivative to time of the position of the motion is less than a maximal value.

46. The computer program product of claim 43, comprising software code configured to produce motion data used to control an actuator to produce an acceleration having a corresponding substantially zero at least one of a third and a higher derivative to time of the position of the motion for an intermediate period between the start portion and the end portion.

47. The computer program product of claim 43, wherein the acceleration is a positive acceleration and comprising software code configured to produce motion data used to control an actuator to produce a negative acceleration of the at least one of the patterning device support structure and the substrate table having a high negative acceleration at least one of a third and a higher derivative to time of the position of the motion, the absolute value of the high negative acceleration at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the corresponding low at least one of the third and the higher derivative to time of the position of the motion.

48. The computer program product of claim 43, wherein the acceleration is a positive acceleration and comprising software code configured to produce motion data used to control an actuator to produce a negative acceleration of the at least one of the patterning device support structure and the substrate table having a low negative acceleration at least one of a third and a higher derivative to time of the position of the motion at a start period of the negative acceleration and a corresponding high negative acceleration negative acceleration at least one of a third and a higher derivative to time of the position of the motion at an end period of the negative acceleration, the absolute value of the corresponding high negative

acceleration at least one of the third and the higher derivative to time of the position of the motion being larger than the absolute value of the low negative acceleration at least one of the third and the higher derivative to time of the position of the motion.

49. The computer program product of claim 43, wherein the acceleration comprises a positive acceleration phase and negative acceleration phase.

50. The computer program product of claim 43, wherein the acceleration comprises a scanning direction.

51. The computer program product of claim 43, wherein the acceleration comprises a stepping direction.

52. The computer program product of claim 43, wherein the motion signal comprises a position signal.